

Linear and nonlinear drift-interchange instabilities in the TORPEX toroidal plasma

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Low frequency electrostatic instabilities are investigated on TORPEX, a toroidal device for basic plasma physics experiments with a toroidal magnetic field ≤ 100 mT and a small vertical magnetic field (≤ 4 mT) [A.Fasoli *et al.*, this conf.]. Electrostatic Langmuir probes are used to measure the equilibrium and fluctuations profiles and the local dispersion relation over the poloidal cross section. The instabilities observed on TORPEX have features qualitatively similar for different experimental scenarios. Bipolar structures are usually observed in the density fluctuations. These structures originate in the region of high fluctuation level, then propagate in the $\mathbf{E} \times \mathbf{B}$ direction. The largest level of density fluctuations is measured where the pressure gradient is maximum and co-linear with the magnetic field gradient. The measured phase velocity, corrected for the Doppler shift induced by the $\mathbf{E} \times \mathbf{B}$ drift, is consistent with the electron diamagnetic drift velocity. The local dispersion relation, measured along and across the magnetic field, is in agreement with the predictions of a linear kinetic slab model for drift waves, taking into account the magnetic field curvature. It is found that the curvature is essential for driving the observed instabilities, which are therefore identified as drift-interchange modes. The measured dispersion relation is observed to vary across the poloidal cross-section. The power spectral density $S(k,f)$ is localized in both f and k at the location where single modes are driven and loses coherency during propagation. A broadening in the wavenumber-frequency spectrum is observed, suggesting nonlinear interaction between frequency components. Mode couplings among triplets of waves are thought to be the building blocks of turbulence. Nonlinear interactions between modes are investigated in the different experimental scenarios by means of higher order spectral analysis techniques. The intensity of three-wave coupling is quantified using the bicoherence spectrum. The linear growth rate of the instabilities and the energy redistribution between modes due to quadratic interactions are inferred from two-point measurements solving a second order Volterra equation.

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